

Management of Real-World Projects in University Computing Courses

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Abstract

Many universities have made it their goal to simulate the experience of the real world as it relate to the projects pursued by students during the capstone course. This prepares the students to manage projects small and large within an organization. It also allows students to see the overall processes involved to produce a product or output for a client. In addition, the student's learn to develop and exercise important skills sets such as technical, managerial, and conceptual skills which is vital in the workplace. Therefore, I have undertaken the task of investigating related literature and university courses that undertake real-world computing projects.

1. Real-World Projects-Capstone

The Capstone course is where students gain real world experience by utilizing learned skills to develop an application or software or concept in behalf of the customers or clients. Students can benefit by attaining real world experience and observing all of the processes involved in the developing a product for the customers as well as learning the value of commitment to an employer or organization. Customers also benefit by achieving a new system or product developed that might not have been cost justifiable otherwise. The University benefits by developing and improving relationships with businesses and academic organizations in the community and beyond [1]. Some course majors that necessitate real world projects are Computer Science, Information Systems, and Internet Technology. It is noteworthy to mention that other majors outside of the IT curriculum also centers on emulating the real world project environment (Business, Medical, and Education). The capstone courses are mostly provided in a one semester format. For instance, I'm currently pursuing my M.S. Degree in Internet Technology at Pace University and enrolled in the capstone class which is provided in one semester.

NYU Computer Science Department also offers a graduate course, Information Technology Projects, which is provided in one semester [2]. In addition, Baruch College offers a graduate course in Information Systems which is available in a one semester format as well [3]. Columbia University deviates from the one semester format by allowing the students to take two semesters of the capstone course which gives students more experience in applying their knowledge and gaining a deeper understanding of the processes and reaching specific goals [4].

The University of Arkansas at Little Rock department of Information Science also deemed it necessary to provide the students with two semesters of the capstone classes as oppose to one semester. The institution thought it would better prepare the student for the corporate world. Some of the educators employed at the University of Arkansas suggested going beyond the lecture format in the classroom setting and therefore, the courses were revamped to allow the students to experience the six phases of a System Development Lifecycle (Analyze, Design, Validate, Implement, Test, and Document) [5].

Many universities believe that making adjustments in the project course design have resulted in better experiential opportunities for the students which provides in depth reality of real world experience, more substantial projects, and environments that prep the student for their careers in the IT field. The new changes assist students in adapting and understanding the importance of team work and developing strategies to manage and resolve conflicts that are encountered while embarking on the team project. Here are some of the major changes that have been introduced at Deakin University in the capstone course project since 1999 shown in Table 1 [6].

Table 1: Comparison of capstone course project versions.

Older Version of Course	New Version of Course
Projects were discipline based, according to major	All majors merged to provide a greater skill set among the team members
Teams of 4 of 5	Teams of 10 to 12
Focus on product (80% to 90% of assessment)	Focus on processes (40%) as well as product (60%)
Simulated, case study projects (often duplicated)	Emphasis on individual projects with real clients
Smaller scope for projects (limited size)	Projects of significant size
Large numbers of supervisors with variations in supervision	Closer monitor of supervisors and fewer of them
Assessment inconsistent (done mainly by supervisors)	Assessment more transparent and moderated by faculty

2. Nature of the Projects

Initially, most projects derive within the university according to the article, “Projecting IT Education into the Real World”, written by Professor Lavon Green from Purdue University Calument. The article explained that through a discussion and notification of the available teams various departments request information systems. Since there are always more requests for projects than there are resources in an organization, departments were pleased that they could get service without having to wait for the availability of the university administrative IT department. Most of the original requests were concentrated on databases to track student performance, faculty performance, inventories of materials, and other relatively simple transaction-oriented systems. The advent of the Internet has spurred on the request for Web sites with database interaction and the development of online courses. However, the database requests have experience a declined because of the integrating of an organization wide database that performs central processing of faculty and student information. Course requests have decreased due to the use of standardized distance learning courseware as Professor Green discuss in his article.

Now it is quite common for a university department to recruit projects from external sources apart from the university. The faculty and staff members are committed to informed local businesses of the resources available. In addition, the IT department manages the task of pursuing outside consulting in which they would explain the availability of resources made via the capstone course. The advisory committee also has a role in defining the direction the course. The

advisory committee, which is composed of business leaders from the community, is responsible for hiring the graduates and alumni of the program. The main purpose of the advisory committee is to contribute to the development of the degree programs based on the needs of the member organization according to Professor Green [1].

3. Projects structure

To satisfy the requirements of the industry and course expectations, the following project design constraints are adhered to:

- Protect confidentiality and proprietary company information as well as maintain the anonymity of the client
- Engage in designing both local and wide area networks to support a sophisticated security and monitoring system
- Focus on the physical and logical security needed to protect company assets and ensure safety in a highly competitive and secretive industry.

In order to create a real world project atmosphere for the students, it is essential to provide a company description and overview. Sometimes a hypothetical company is created for the team to belong and manage. The whole idea of the project is to create a real world scenario in which the students can solve actual organizational problems and capable with presenting a complex and challenging situation to apply the knowledge and skills learned through out the curriculum as well as having the opportunity for research in their perspective fields as proposed by the school of Pennsylvania College of Technology [7].

Humboldt State University capstone course is commonly one semester long. Projects undertaken by the team or group accounts for a large percentage of the grade and includes a number of milestones that ultimately leads to the final project submission. Working in teams is mandatory except when difficulties arise that require attention; for instance, when there are problems related to programming aspects of the project. Teams are designated by the instructor which is preferable than self-selection because it resembles a real world environment where people are assigned to projects. During the beginning of the course, the students are provided a self-assessment of their skills in several areas. On a scale of one to ten, students are asked to rate their programming skills, graphic design skills, and people skills, and so forth. Other questions appropriated to ask by the professor are: Are you a full-time or part-time student? Are you working and attending classes and

how many hours per week are you working? These essential questions will assist the professor in making an evaluation of the students' skills. He or she can begin to assemble the teams using the information gather by the students. A typical course workload for a capstone course in any IT related major is shown below. A typical capstone course workload

Week 1	Team assignments handed out, project handout and suggested possible projects handout
Week 2	Milestone #1 due: Project Selection
Week 3	Milestone #2 due: Preliminary Schedule, in Gantt chart form
Week 5	Milestone #3 due: Database Model, including either entity-relationship diagrams or semantic object diagrams
Week 8	Milestone #4 due: Team presentations, during the lecture/discussion session, to describe progress so far
Week 8	Milestone #5 due: Database Design/Schema, during the lab session
Week 9	Milestone #6 due: Forms progress report
Week 11	Milestone #7 due: PL/SQL progress report
Week 13	Milestone #8 due: Report progress report
Week 15	Milestone #9 due: Team presentations, during the lecture/discussion session, to describe progress since the earlier presentation
Week 16	Milestone #10 due: Final version of project handed in, and demonstration of final project to the class and to department faculty, during the final course lab session
Before final:	Milestone #11 due: Individual paper, giving some overview of their team project experience, including discussion of what was learned and how the team was successful or unsuccessful

The table reflects a capstone course from the Department of Computer Science at Humboldt State University. It is quite obvious that this course workload primarily focused on a database project. However, any project selected whether it is Web base project or some other project development, this provides a basic overview of the course workload which is administered on a weekly basis by the professor [8]. In addition, peer-evaluation forms are often given through out the course or sometimes at the

end of the course for the professor to review. It helps the professor to assess the students' performance and commitment to the project. It also helps the professor to determine the teams' grades.

4. Project Teams and Assignments

According to Dr. James E. Novitzki from Johns Hopkins University, the professor assembles the teams and assigns the various teams to a project. He or she must assure that each team is balanced (skills) and properly sized (typically 3-4 students). It is noteworthy to mention that the team makeup is a critical component whether or not that the team will fail or succeed. For instance if the team is possess with individuals with a limited mix of skills, the chances of the team performing satisfactory on a project is less. There is some flexibility with team assignments. If after initial assignments have been made, students who request to be transferred to another team are sometimes permitted. If a student is transferred to another team, then a student must replace that student who left to fill the team's gap.

After the teams are form, they usually meet with the faculty advisor to choose a team leader who will serve as the team liaison. This person will be the team's point of contact for the professor and the sponsor. Another purpose for the meeting is to emphasize to the students the importance of the group working as a team and where they exists gaps in their technical knowledge or experience, as a whole unit their knowledge and experience level is relatively high.

5. Project Team and Project Sponsors

Johns Hopkins University has the team members compile questions or a survey to be distributed to the project sponsor. These questions would help the group ascertain crucial information about the company, project, industry, etc. The team leaders take the lead in scheduling a meeting with a representative from the company or the project sponsor. It is normally a person (project sponsor) who can provide a general overview of the project details, scope, and requirements. The meetings are held on the company premises. After meeting with the company representative, the teams congregate to elaborate on the processes to complete work within in the sufficient time frame. A scope statement is created by the team and provided to the faculty advisor. The faculty advisor and the project sponsor give his or her recommendation and have the team's revised scope statement. On completing the scope statement, the scope statement now serves as a contract between them

and the project sponsor. Future meetings with the project sponsor are crucial in order for the project to prove successful. Along with meeting with project sponsors, independent research and working cohesively with the project sponsors are vital to completing the project in an appropriate time frame. Their goal is to develop a great functional system or research information or solution, given the knowledge of the organization and its dilemmas.

The teams' workload depends on the nature of the project. However all projects require determination, commitment, and time. Students at Johns Hopkins University are expected to dedicate time to meet outside of class and at the project sponsors site. Meetings with the sponsors depend on the needs and the requirements of the project. For some teams, three to four times during the term would be sufficient to meet the demands of the project and project sponsors. Other teams might be obliged to meet with the project sponsors on a weekly basis to assure the team and the sponsors are abreast of the progress concerning the project. In cases where the project encompassed a high involvement of a technical nature or surveys, numerous meetings are pursued by the team members in order to complete the project. Since the team project simulates the real world, students must learn that projects do not always run smoothly as expected. Therefore, the faculty advisor uses the workload issues as a way of reinforcing the need to staying within the boundaries of the project scope. Because of the demands placed upon students in the capstone class, students are encouraged to take a no other classes or a reduce course load the semester that they will take the capstone course as recommend by the staff at Johns Hopkins University.

6. Projects, Project Sponsors, and Students

The capstone course concentrates on the project sponsor's project. Some common constraints are that the projects can not be mission critical, involve highly proprietary information, be time critical, involve extended time frames, involve travel to distant locations, or be merely an implementation of some technology at the technical level. Also, students desire a project that is in harmony with their course study. However, it can be quite a task for both faculty and administrative staff to locate projects that meets the expectations of the students as Dr. James E. Novitzki relates in his article, "Critical Issues in the Administration of an Integrating Capstone Course. Dr. Novitzki further explains that many types of projects that are selected comprise of upgrades, modifications, and other technical expertise on information systems which is due to the fact that many companies no longer

employ or use legacy base systems. Companies seek to conform to the Web and B2B models of conducting business. With the integration of new technologies (PHP, Javabeans, XML, VRML, and etc.) on the Web, businesses have been progressively migrating to these new technologies. Therefore, some of the projects would require students to look at issues, products, and technologies to establish if it would be feasible for the project sponsor meaning would it be cost effective or have scalability. Some projects are purely research and have no hands-on component. This is the case when exploring new technologies. Of course, students prefer a hands-on project. But the student must realize that at the Master level, the IS professional is not the hands-on running the cable techie. The project sponsor will correctly point out that senior IT personnel will expend considerable time performing some of research. I've known this situation to be true. In the real world, IT personnel may be requested to research a new technology for the company to use before actually getting their hands dirty.

In order for the student to meet the demands of the real world, students must develop a conceptual overview of the project sponsor organization. This would entail looking at the system and its components and considering what changes are required to make the system more efficient and effective. The idea is to help the organization meet its goals as it relates to the project. To accomplish these demands, the IT person must bridge the gap between the engineers, technical experts, and the functional managers. It is very important for the faculty to stress the nature of the capstone course and objectives during the orientation. The capstone course should not be just subjected to problem solving and technical issues as far as Johns Hopkins University is concern. It should emphasize the IT role within the organization. The faculty advisor and professor should reinforce this approach and take a more global perspective on the issues involving the project [9].

Peter Denning and Robert Dunham discussed the IT profession and the IT professionals in their article, "The Core of the Third-Wave Professional". The article highlighted that employers aren't satisfied with the IT graduates due to lacking the considerable skills that are crucial to carrying out business functions. Among the skills lacking were current IT trends and soft skills including presentation, customer relations, leadership, and team work. The article focused on obtaining a Customer-Centric mentality toward the IT profession, it introduced an interesting perspective on the role of IT professionals. By examining the role of the IT professional in relation to the customer, results to making a value-producing promise. They also mention that it applies not only to the ordinary notion

of someone purchasing a product or a service, but also to users of software systems, to clients of IT professionals, to students of IT teachers, and team members with each other and their team leaders. Two other terms that were accentuated were technical skills and value skills. But for the purpose of this discussion, we will focus on the value skills mentioned in the article. Dennings and Dunham brought to our attention that value skills are part of the cores skills of an IT professional and it's the component that connects professional's technical expertise to the customer. In addition, without value skills, customers will not evaluate as knowledgeable. It is evident that value skills are great for business. As mention in the article, "If every action within a business transaction brings value to the customer, there is no waste. Furthermore, the capstone project courses were recommended as a terrific platform for teaching value skills. Below is a list of value skill shown in Table 6 [10].

Table 6: A list of value skill sets

Value Skill Sets	Examples
Coordination	Request, offer, promise, negotiate counteroffer, defer, decline, insist
Customer Relations	Listen for customer concerns, articulate a value proposition, make declarations, co-design value propositions with customers
Commitment Management	Maintain commitment records, allocate time and resources to each commitment, adjust load to one's capacity, communicate with customers about progress, build trust through a history of kept commitments
Teams	Declare a mission, invite members, make commitments to the team leader, manage commitments together, measure progress, share assessments with the team, raise and resolve red flags
Lifelong Learning	Understand levels of professional competency, seek situations and mentors for advancement, obtain certifications of professional competence from recognized authorities
Business and Entrepreneurship	Listen for widely held concerns, follow and interpret trends the world, identify innovative practices that can solve central problems, build an offer, a business plan, and a team, practice within a code of ethics

7. The Faculty Advisor, Professor, or/and Coach

Some universities like to perceive the role of the professor or faculty advisor as a coach. For instance, Brigham Young University department of Mechanical Engineering assumes this coach methodology approach toward the capstone course as explained by Dorothy G. Taylor, Spencer P. Magleby, Robert H. Todd in their article, "Training Faculty to Coach Capstone Design Teams".. They profess that a successful learning experience for the capstone design teams require faculty to shift their role from a traditional lecture or consulting role to a coaching role. According to their research, the coaching concept is deemed necessary to the successful of the capstone educational experience. The success for the Capstone experience is identified in three areas: learning and application of design processes, understanding of and skill in team processes, and successful result of the project itself. Their belief is that a successful project result reinforces process learning and builds the confidence that is imperative to be successful at later projects in the industry.

Brigham Young University research shows that a successful coaching role comprises three main responsibilities:

1. Mentor: providing support by showing the way. Being there, aware and helpful.
2. Mediator: a buffer between external reviewers and customers.
3. Manager (Facilitator): guiding the team in both team processes and the design process.

It was pointed out that the timing and the degree to which the coach will embark on these responsibilities will particularly depend on the necessities of the teams. However, the coach will be required to modify responsibilities of the team members at some point during the capstone course according to BYU research data. It is noteworthy to point out that it is not only what a coach does, but also how he or she does it that makes a successful team project experience. Many levels of coaching training have been implemented in BYU's capstone program since its inception. Seminars have been provided to deliver coaching tips and information. Also, an environment for discussing issues of concern is made available. They are convinced that in order to have a successful outcome in the capstone experience, experimental changes and training for coaches are necessary. Outcomes observed in regards to the training are:

1. Providing support for coaches by way of training seminars are key in changing from a traditional faculty role to a coaching role.
2. Focusing on key indicators and activities gives coaches tangible tools to lead to a successful team/project experience.
3. Coaches' desire and need feedback on their coaching performance during the experience in order to more effectively coach their team.

Shown below is the capstone coaching role expectations and activities in team and design processes [11].

Team Process: Helping students become effective team members

Learning

General capstone expectations

Support lecture and lab information

Keep team on track for success

Specific activities (Processes of Learning)

Positive verbal comments

Watch for/encourage key indicators/activities

Periodically evaluate/give feedback

Apply learning to team experience

General capstone expectations

Specific team processes in place

Specific team member roles

Effective team member relationships

Effective relationship with the liaison

Effective relationship with the team leader

Specific activities (Processes of Applied Learning)

Initial team process discussion

Reflection on team processes, as needed

Establish team member roles, including team leader

Team opening social

Encourage open communication

Initial team meeting with liaison

Weekly contact with liaison

Weekly meeting with team leader

Design process: Helping students become competent design engineers

Learning

General capstone expectations

Support lecture and lab information

Keep team on track for success

Specific activities (Processes of Learning)

Positive verbal comments

Watch for/encourage key indicators/activities

Periodically evaluate/give feedback to each team member

Applying to project

General capstone expectations

Appropriately scope project

Common understanding of project

Monitor project progress

Specific activities (Processes of Applying to Project)

Final scoping of project with liaison (prior to team input)

Additional scoping, if needed

Initial team project discussion (following initial team process discussion)

Attend weekly team meetings

Give helpful suggestions/guidance

Show how to do parts of design process

Ensure weekly liaison contact

Assist team in planning for and reflecting on reviews

Assist team in self-assessments

Review team deliverables

Supervise team budget

8. Project Deliverables

The department of Industrial Technology at California Polytechnic State University defines the project deliverables as the following:

- A physical product prototype, a plan for improving a management system or procedure.
- Intermediate progress reports.
- A written formal report on project activities.
- An oral presentation to a technical or industry advisor.

The items listed above are typically common to all capstone programs and it is important to achieve a satisfactory grade in the course [12].

9. Conclusions

The capstone course benefits the students, faculty, and sponsors. In addition, the capstone course benefits the department and the university. Students obtain real world experience and develop skills required to maintain and survive in a fast pace industry. The faculty gets to evaluate the successfulness of the curriculum and therefore, make the required improvements for the following semester. Students also relieve the faculty of some of the work load in terms of supervising the project activities. Sponsors benefit by deriving a new product/system or improvement of a system. They also benefit by receiving exposure or making students aware of their company presence. The university benefits by making discoveries or becoming responsible for a new product or idea that can perhaps be useful to the sponsors and the general public. A successful product also demonstrates the value of the education that the students are receiving at their university. Students are most likely to keep in contact by participating in the

alumni event provided by the university [13]. I will conclude with some quotes provided by students from University of West Florida who were part of a capstone course called "Life Choices: The search for Meaning Honors Seminar" [14].

"This capstone project is not finished because I am not finished and I am not perfect".

"I did not know that much of myself even though I am myself"

"As we continue talking about the hero's journey, I hope and predict that our journey will become clearer, and perhaps with significant exposure to the journeys of others and how their lives were moved, we will be prepared for our own"

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